

Traffic Service Position System No. 1: Busy Line Verification Feature

By J. ATKINS, K. A. RASCHKE, and D. L. WOODY

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The Busy Line Verification feature is a recent development in the Traffic Service Position System (TSPS) No. 1. This feature allows a TSPS operator to verify the busy or idle state of a customer line. Based on a calling customer's request, the TSPS operator initiates a connection of his or her position through a dedicated switched network to a special trunk in the end office of the line to be verified. The operator can determine from a console lamp if the phone is off-hook and can listen for conversation on the line. To protect customer privacy, a special circuit scrambles the conversation to make it unintelligible—but still recognizable as speech. By depressing a key on the console, which deactivates the scrambler and generates an alerting tone, the operator is also able to interrupt conversation and deliver an emergency notification. The new verification feature also provides for automatic message accounting records and for coin and hotel charge quotations when tariffs include charges for verification. By serving busy line verification requests that previously had to be handled through manual switchboards, the new TSPS feature saves operator time and costs for the operating company.

I. INTRODUCTION

1.1 The Traffic Service Position System No. 1

The Traffic Service Position System No. 1 (TSPS No. 1) was introduced into the Bell System in January 1969 to provide operator services more efficiently, to make the telephone operator's job more attractive, and to allow customers to dial many of their own operator-assisted calls.^{1,2} This operator services system employs stored program control to automate routine tasks such as recording originating numbers, recording and transmitting called numbers, recording call duration, and determining billing charges.

This automation allows the operator to concentrate on the more complex judgmental tasks involved in communicating with customers. In addition, it results in faster call completion, higher operator efficiency, and more accurate billing. All these characteristics benefit both the customers and the operating companies.

Originally, the capital expenditure necessary to provide TSPS service was more easily justified in a large metropolitan area than in a sparsely populated area with a low volume of operator toll traffic. By 1976, however, a means of providing TSPS benefits to small suburban and rural toll centers was developed and introduced into the Bell System. This TSPS subsystem, called the Remote Trunk Arrangement,³ provides voice trunks and data links that connect the TSPS operators and stored program control to equipment located in remote toll offices. With this development, toll traffic generated over a large geographic area can be handled by a single centralized TSPS controlling up to eight Remote Trunk Arrangements. At the present time, TSPS's operating in conjunction with local and toll switching systems provide improved operator services to over 85 percent of Bell System customers and to many customers served by independent telephone companies.

The original TSPS design did not include handling some lower volume toll traffic, such as conference, hotel-motel, mobile, marine, international, inward to operator, and busy line verification calls. These functions were assigned to special operator service traffic cord switchboards. Since staffing these cordboards requires special operator training and scheduling, the costs associated with special operator service traffic are disproportionately higher than those for TSPS-provided services. The use of stored program control in the TSPS design facilitates the addition of new features to the TSPS operator services system. Hence, over the past several years, many of the cordboard operations have been incorporated into TSPS. In particular, hotel-motel, international, and some inward-to-operator calls have been included.

Besides the incorporation of cordboard functions into TSPS, other advances have occurred with the further mechanization of operator tasks. A notable example is Automated Coin Toll Service,^{2,4} which was introduced into the Bell System in 1977. This feature automates the handling of most coin toll calls by providing machine-generated announcements and automatic detection of coin deposit signals.

Recently, these efforts to handle operator services traffic more economically have continued with the introduction of the busy line verification (BLV) feature in TSPS Generic 1T9.

1.2 Background for the busy line verification feature

A busy line verification request is usually made when a customer has made repeated unsuccessful attempts to reach a busy line, or when

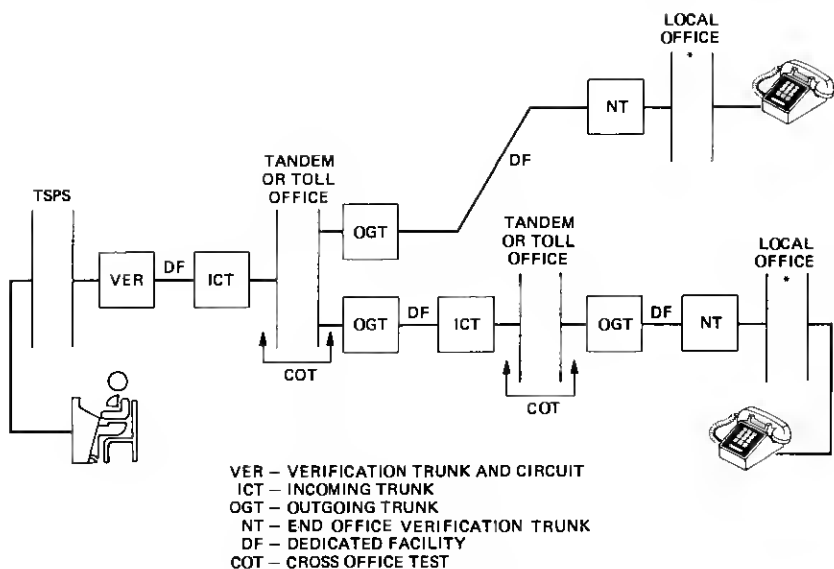
a customer, in an emergency situation, requires that a busy line be cleared. To obtain a connection to the busy line, the special operator service traffic operator today usually has access to a special trunk in the local office which terminates the busy line. This trunk has the ability to establish a bridged connection to the customer's line even though the line is busy. Once the connection has been made, the operator is able to determine whether there is conversation on the line. In some cases, the operator also receives a visual indication of the supervisory (on-hook/off-hook) state of the line. In an emergency situation, the operator is able to break in on the customer's conversation and request that the customer clear the line. At no time is the customer requesting the verification connected to the customer on the line being verified.

Busy line verification calls have been a significant component of special operator service traffic and, indeed, some cordboards handled only BLV traffic. For this reason, several operating companies developed their own BLV arrangements to either eliminate or reduce the number of cordboards. Some of these companies chose to close many of their small toll center switchboards and centralize the switchboard functions in a few locations. To do this, the special local office verification trunks were either extended directly over dedicated facilities to the centralized cordboard or were extended to a tandem office and then to the switchboard locations over dedicated facilities. Other companies opted to develop their own dedicated BLV networks which, typically, can be accessed by TSPS's. These networks differ as to the types of toll and local switching offices that can be accessed by the TSPS's. Other differences relate to the privacy and security features incorporated in the network.

Because of the economic advantages of eliminating switchboards and of providing uniform arrangements for verification networks in the Bell System, a standard BLV service has been developed for TSPS. This BLV design has the capability of operating with a wide range of toll and local switching offices; it also includes privacy and security features as part of the standard arrangement.

II. STANDARD VERIFICATION NETWORK—OVERVIEW

To handle busy line verification in a standard fashion, dedicated verification networks are being deployed. Existing TSPS offices, toll offices, and end offices are components of these networks, along with interconnecting transmission facilities. Figure 1 is a block diagram of a simple verification network. A TSPS gains access to the verification network via a single dedicated trunk group to a single toll office. If more than one toll office is homed on the TSPS, one of these toll offices is normally selected as the verification network interface for that TSPS.



* A SIGNAL LIMITER MAY BE REQUIRED FOR ELECTROMECHANICAL AND 2ESS OFFICES

Fig. 1—Verification network.

In the TSPS office, a verification circuit is associated with a 4-wire outgoing trunk and a 3-way/4-wire bridging repeater arrangement. The verification circuit contains a scrambler to distort the signals on the line being verified, making any conversation on the line unintelligible to the listening operator but still recognizable as speech. Busy or reorder tones are frequency-shifted by the scrambler circuit, but are identifiable by the operator. If operator intervention on the line is necessary, the distortion is eliminated from the connection, and a beep tone is automatically applied to alert the subscriber to the operator's presence.

The TSPS verification trunk is connected, via dedicated facilities, to an incoming verification trunk in the toll office. The toll office provides either (i) a link to an outgoing trunk and dedicated facilities to another toll office or (ii) an outgoing toll connecting trunk and dedicated facilities to an incoming verification trunk in a local office. Each toll office has arrangements to ensure the security of the verification trunk connections. Electronic toll offices use two independent office data translations to provide this security, while electromechanical toll offices use an electrical cross-office check signal or a segregated switching train to control the trunk-to-trunk connection. The trunks in all verification network offices are arranged to return supervisory signals

to the TSPS from the line being verified. The TSPS verification trunk detects this supervision from the verification equipment in the local office via the interconnecting toll offices. The toll office trunks are generally arranged to return a reorder signal to the TSPS if any portion of the verification network is operating at maximum capacity and the connection cannot be advanced.

At certain local offices, BLV signal limiter circuits are installed. These circuits limit the amplitude of signals generated by local offices, thus preventing high-level signals from reaching the rest of the verification network. Since BLV trunks share common carrier and wire facilities with normal direct distance dialing (DDD) traffic, unlimited high level signals could interfere with this DDD traffic by causing crosstalk or overloading.

III. GENERAL DESCRIPTION OF TSPS BUSY LINE VERIFICATION FEATURE

When a customer requests verification of a busy line, the TSPS operator first tries to place a call to that line over the DDD network. This allows the operator to hear the symptoms encountered by the customer. This is useful if the customer did not understand an announcement or if a reorder tone indicated that all trunks to the called point were busy. In these cases, it is not appropriate for the TSPS operator to attempt to verify the requested line. It is also possible that, when the TSPS operator places the DDD call, the call will go through. This may occur because the called party has completed a previous conversation or because the called line is a "hard-to-reach" point that can be reached by the operator but not by the calling party. When the TSPS operator decides that a busy line verification is justified, the verification is attempted. The customer is placed in hold during the verification process and does not hear either the operator or the verified parties.

The calling customer may also ask that the operator interrupt the conversation on the busy line to request that the line be released to receive an emergency call. In this case, if the operator determines that there is, indeed, conversation on the line, the conversation can be interrupted by the operator. The operator cannot disconnect the call in progress, but can only request that the line be released. The operator also cannot connect the calling customer to the requested line except by the normal means of placing a call to a free line.

Provision is made in TSPS for automatic billing of a charge for verification and a separate charge for emergency interrupt (either charge may be zero). In addition to the normal billing to the calling line (noncoin phone), the capability is provided for the customer to pay for the charges directly (coin phone) or to bill the charges to a

room number (hotel/motel phone), to a credit card, or to another customer line.

IV. OPERATOR HANDLING OF A BUSY LINE VERIFICATION CALL

4.1 Modifications to the TSPS operator console

Two new keys are used by the TSPS operator to perform the busy line verification functions. The VFY (verify) key is depressed to indicate that a busy line verification is to be performed. The EMER INT (emergency interrupt) key is used to interrupt the conversation on a busy line. These keys are located in the upper left portion of the position key shelf as shown in Fig. 2.

4.2 Initiation by operator

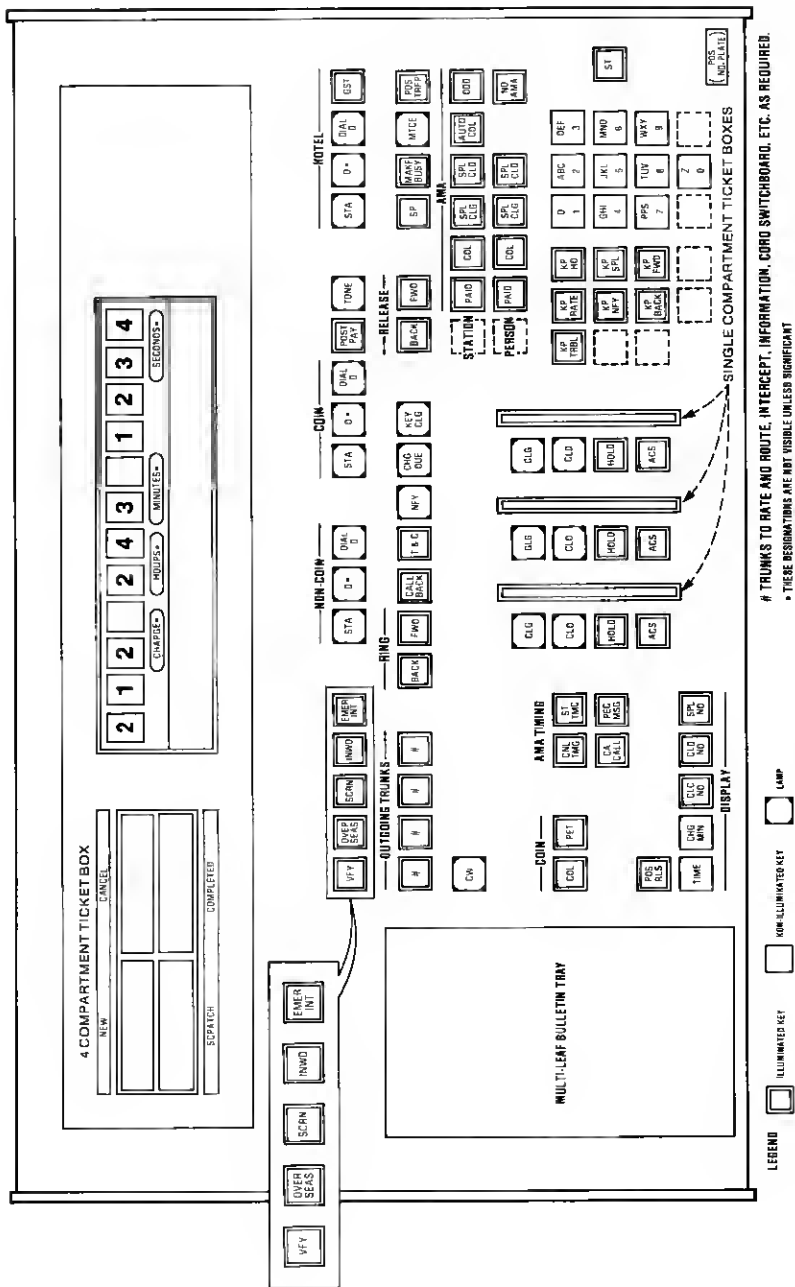
The initial portion of a busy line verification request is handled like a normal call. The operator enters the forward number, if it was not already dialed by the customer. Information necessary for billing a normal operator-handled call is also entered in case the call completes normally. The call outpulses over the DDD network. If a busy condition is encountered, the operator releases the forward connection in the DDD network.

The operator then depresses the VFY key to initiate a busy line verification. At this point, TSPS determines whether all information necessary to perform the verification has been entered and whether the line can be verified. Some specific checks are described in the following paragraphs.

The line to be verified must be within the scope of the verification network served by the TSPS. Data are stored in each TSPS identifying the local offices that can be verified by that site. If the line cannot be verified by the TSPS at which the operator is located, the VFY lamp flashes when it is depressed, and the number to be verified is displayed.

An operating company can also identify bands of lines that should not be verified even though they fall within the scope of the TSPS's verification network. Such lines may be ones for which verification cannot be accomplished because of access limitations, such as lines served by some PBXs. Lines on which customers have requested not to be verified, such as a police emergency line, can also be included. When an attempt is made to verify a number included in this list, the VFY lamp flashes when it is depressed. To distinguish this case from the case of offices not in the network, the number for which verification was requested is not displayed.

If all the conditions for busy line verification are satisfied, the VFY lamp lights steady. After a class of charge is entered, if appropriate (see Section 4.6), the customer is informed that the operator will be off the line temporarily.



4.3 Performing the verification

After the VRY lamp lights steady, the operator places the calling customer on hold. The operator then accesses an idle loop on the operator position. The ACS (access) lamp for this loop lights steady if a verification trunk is available. The operator outpulses over the verification network by operating the ST (start) key. The verification circuit described earlier is activated at this time. The operator then listens for "scrambled" speech on the line and watches the CLD (called) supervisory lamp for the verification loop. The CLD lamp, which was lighted when the loop was accessed and which remains lit for an on-hook condition, darkens if the line being verified is off-hook.

If conversation is detected on the line, the operator can interrupt the line by depressing the EMER INT key. If this is done, the operator and the customers on the busy line hear the alerting tone and the scrambler is disabled. The verified number is also displayed to the operator. After ascertaining that the proper line has been reached, the operator informs the parties on the line of the request to free the line for an emergency call.

4.4 Completing the verification

The operator returns to the calling customer by placing in hold or releasing the verification loop and accessing the calling customer's loop. The operator informs the customer of the results of the verification or interrupt. If the requested service was successfully performed, the operation of the REC MSG (Record Message) key completes the verification. If the EMER INT lamp is lit, the interrupt as well as the verification is automatically billed. Otherwise, billing is for a verification only. If the service was not completed successfully, the VRY key can be redepressed to indicate that the verification should not be billed.

4.5 Completing a call to the verified line

If requested to do so, the operator can complete a call via the DDD network to an interrupted line that has been released. This is done by entering an appropriate class of charge and depressing the ST key. The call is then handled by normal procedures.

4.6 Charging capabilities

Provision is made in TSPS for the necessary information to collect charges for busy line verification and for emergency interrupt. The charges may be paid for by the customer or billed to a credit card or to another customer line. They may not be billed to the line being verified. The details of the service provided are recorded on the Automatic Message Accounting tape for later processing by the Rev-

enue Accounting Office. Charges are displayed for the operator on coin-paid calls. Quotation of charges on hotel-paid calls is also provided.

The coin-paid and hotel-paid rates are stored in TSPS memory since they require immediate quotation. Other types of billing are handled later by the Revenue Accounting Offices. The coin and hotel rates are specified separately, so they need not be the same.

4.6.1 Allowable classes of charge

Information for billing the verification and/or interrupt is also needed. This information is normally entered prior to performing the verification, although it can be entered later. The allowable classes of charge are STATION PAID and STATION SPECIAL CALLING (for credit card or third number billing). The NO AMA class of charge is also allowed if manual rating or unusual billing is required.

4.6.2 Collecting charges from coin customers

On a coin-paid call, an automatic coin return is performed when the VFY lamp is lighted steady. The charge display for the normal call is extinguished at this time. It is replaced by the BLV charge display.

The charge display for BLV actually consists of two charges displayed together. One amount is for the verification charge, the other is the additional amount for emergency interrupt. The CHARGE MINUTES strip is also lighted. For example, if the verification charge is 25 cents and the additional charge for an interrupt is 15 cents, the display would be as shown in Fig. 3. Since both the verification and interrupt charges are displayed together, the operator has the flexibility to collect the proper amount at the proper time.

The BLV charge display is extinguished whenever the operator turns off the VFY lamp by depressing either the VFY or REC MSG key. In addition, when the VFY key is used, an automatic coin return is performed. When the REC MSG key is used, an automatic coin collect is performed.

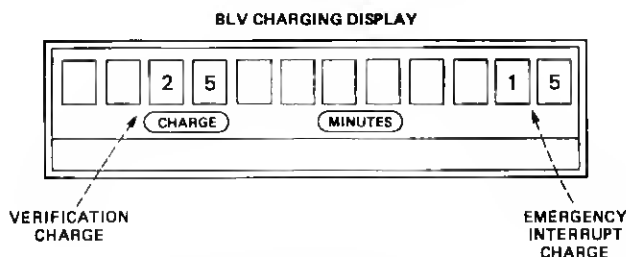


Fig. 3—Console numeric display.

4.6.3 Quotation of hotel charges

For a paid hotel call, if BLV charges apply, they are sent to the appropriate location after the verification is completed. This location may be a Hotel Billing Information System (HOBIS), a Hotel Billing Information Center (HOBIC), or a teletypewriter at a hotel. The charging information appears in the same format as the charges for a normal hotel call, except that the quotation is followed by a "V."

4.6.4 Automatic message accounting records

Automatic Message Accounting records for BLV are essentially the same as for normal calls. They may be station paid, station special calling, or "NO AMA," or no class of charge records. An optional data group is added to indicate a BLV call. The leftmost digit in this data group contains 1 if only a verification was performed, or contains 2 if both a verification and an interrupt were completed. If the VFY key is used at the completion of a BLV attempt, indicating that the attempt was not billable, the billing record is marked as "no charge."

4.7 Inward busy line verification

Inward calls occur when the first operator (called the originating operator) requires the assistance of a second operator (called the inward operator). Thus, when a customer requests verification of a busy line that can only be reached through the verification network of another operator location, the originating operator initiates an inward call.

The call arrives at the inward operator's position with the inward lamp lighted. The originating operator announces the verification or interrupt request and passes the called number verbally. The inward operator enters this number and attempts to complete a call to that number over the DDD network. If the line is still busy, the inward operator follows the same procedures as an originating operator would except for billing. For billing, the class of charge is always NO AMA, and the VFY key (rather than the REC MSG key) is used by the inward operator even if the verification is chargeable. The results of the verification are communicated to the originating operator and the requesting customer by the inward operator.

If there is a charge for the verification, the originating operator prepares a billing ticket. The originating operator also collects or returns coins, as necessary.

V. VERIFICATION SECURITY AND CUSTOMER PRIVACY

Security and customer privacy are essential aspects of any acceptable verification arrangement. The design intent of the standard veri-

fication system was to give tight security against would-be abusers outside the telephone system and to provide adequate privacy from telephone company personnel during normal use. The main elements that allow the standard verification arrangement to meet these objectives are described in the following paragraphs.

5.1 *Speech distortion (scrambling)*

A scrambler circuit located at the TSPS produces scrambled speech for the TSPS operator. Conversation on the rest of the verification network is not scrambled, but the customer's privacy is protected by the dedicated network. For this reason, highly sophisticated scramblers such as those used in military communications systems are not necessary.

While conversation on the verified line is scrambled to make it unintelligible, the operator is still readily able to differentiate speech from other signals such as tones or music. Other important scrambler characteristics are: the original speech is not easily reconstructable, the operator can deactivate the scrambler to permit conversation with the verified customer, and the scrambler may be disabled by a craft-person under controlled conditions during trunk testing.

5.1.1 *Scrambler design considerations*

Besides the need for the operator to be able to differentiate tones and music from speech, it is important that the operator be able to recognize the different telephone system signals or tones that may be encountered in the course of a verification call. Some of these signals are single frequency, others are multifrequency, while still others are interrupted at specific rates. The most important of these tones are "busy" and "reorder," which may be heard by the operator when verification network blockage is encountered, and data transmission signals, which will be heard if a data link is verified (e.g., if the verified customer is using a computer terminal acoustically coupled to the line). Thus, it is important that the scrambler not completely destroy the tonal characteristics of the transmission, nor make the interpretation of interrupted tones difficult. To meet these objectives, a scrambler circuit design was chosen that does not use low-frequency chopping (which would interfere with interrupted signals) and that does not shift any of the desired tones out of the operator's audible range.

There is another reason to limit the amount of distortion (scrambling) introduced. Distortion adds to the normal impairments (noise, crosstalk, etc.) that exist in a telephone transmission system. Thus, more distortion reduces the margin between speech which is unintelligible but discernible and speech which is unrecognizable as such. For this reason, the scrambler produces only enough distortion to make

voice signals unintelligible. Any further distortion would only serve to lessen the voice detection margin and would reduce the length of the transmission paths usable in verification networks.

Finally, it should be noted that the circuit design includes the capability to detect certain failure conditions that could otherwise compromise the integrity of the verification system (see Section 5.6).

5.1.2 The scrambling technique

One method of distorting voice transmission is to "beat" or modulate the speech with a fixed carrier frequency. This modulation procedure, which is also a frequency shifting process, is used extensively by the radio and TV broadcasting industry to translate voiceband signals to a more desirable frequency for transmission purposes. That is, the voiceband is usually modulated out of the audio range to a much higher frequency for transmission, and is then demodulated at the receiving end so that it may be understood by the listener. Such systems can employ either single or double sideband modulation and can be transmitted with or without the carrier.

If, however, an audible frequency is used for the carrier instead of a radio frequency and if the phase reversing properties of double sideband suppressed carrier modulation are taken advantage of, and, finally, if this signal is not demodulated, then the resulting transmission has a voice-like sound that is not understandable. Also, if the proper carrier frequency is selected, telephone system signaling tones are not shifted out of the audible band. There is a problem, however, with the audio frequency carrier since it would be present even in the absence of a modulating signal. This carrier would interfere with the detection of interrupted signals (e.g., busy, reorder) by "filling" in the interrupted intervals. To overcome this problem, suppressed carrier modulation is used. With this type of modulation, the carrier is not present if there is no modulating signal. In other words, nothing will be heard during breaks in conversation or during the interruption intervals of busy and reorder signals. Suppressed carrier modulation also provides an added security benefit, since it is very difficult to demodulate unless some representation of the carrier is available.

The total result of this frequency shifting, coupled with the phase reversing characteristic of double sideband suppressed carrier modulation, produces an audible spectrum which renders conversation unintelligible. However, the effect on signals that must be understood by the operator is to simply translate them to different frequencies within the audible bandwidth. Since many of these signals are a mixture of several tones to start with, the tonal quality of the translated mixture is similar to the original.

Since the make-break cycle of the interrupted tone signals (busy,

reorder) has not been interfered with, these signals are readily identifiable. The distinctive warble of data transmission signals and the raucous sound of the receiver off-hook signal can also be easily discerned. These are the most important of the tone signals heard by the operator.

Subjective human factors tests using maximum operator background noise and maximum circuit noise conditions have been made. The results of these tests show that there is only a slight (about 4 percent) degradation in the ability of untrained subjects to identify scrambled versus unscrambled voice and signals.

5.2 Alerting the verified subscriber

The purpose of the beeper, with its alerting tones, is to notify the subscribers being verified that an operator has bridged onto the connection. A 2-second initial tone burst serves as the primary subscriber alerting function. This 2-second tone also cues the operator to deliver the emergency announcement. After the initial tone, a secondary tone is generated at 10-second intervals until the connection is released.

5.3 Dedicated facilities with trunk class marks

All TSPS/toll office, toll office/toll office, and toll office/local office interconnecting verification network facilities are completely dedicated to BLV traffic. This is accomplished at toll offices by exclusive class marks that restrict trunks to handling verification traffic.

5.4 Codes for routing translations

To protect against the chance of an unauthorized person gaining access to the verification network, special routing codes are prefixed to verification calls. Each area code within a TSPS verification network is assigned a special routing code. The toll office screens the dedicated incoming verify trunks for the proper prefix and denies network access to unprefixed calls. Therefore, even in the unlikely event of trunk misassignment, a nonprefixed call will not pass the toll office screening, and the security of the network will be maintained.

5.5 Toll office security checks

Basically, two types of toll office security checks are used to ensure that incoming and outgoing verification trunks can be connected only to each other. For Nos. 1 and 1A ESS, No. 4A Crossbar with ETS, and No. 4 ESS, software and office data checks are used in making the cross-office connection. For No. 5 Crossbar and Crossbar Tandem offices, electrical cross-office checks are made to ensure the correct connection. Step-by-step intertoll offices route verification traffic via

a segregated switch train. In all cases, access to the verification network is restricted to incoming verification trunks.

5.6 BLV operational test

Historically, diagnostic testing of the transmission characteristics of TSPS trunks has been initiated by operators. That is, if an operator experienced a transmission problem in the course of a call, the operator would file a trouble report for use by the craft. The operator would also probably cause another trunk to be selected to complete the call. With BLV, because of the sensitive nature of the verification network, an additional method of fault detection is provided. Since certain scrambler and/or beeper failures could possibly permit unauthorized surveillance of the customer's line, it is imperative that verify circuits exhibiting such faults be promptly detected, automatically removed from service, and a new circuit selected to provide the verification service. The faults which require timely detection are (i) a missing or low power beeper signal and (ii) an undistorted scrambler output.

These faults are detected via an operational test of the BLV circuits. This test is made automatically before a circuit is used for a verification attempt. It is made by looping the output of the tone generator through the BLV trunk and into the input of the scrambler.

A correctly operating scrambler converts the beeper tone generator output into energy at higher frequencies. A detector circuit monitors the level of this energy at the scrambler output for correct operation (see Fig. 4). The result of the detector output check is reported, via a scan point, to the Stored Program Control. In addition, a second part of the operational test checks the detector output with the scrambler disabled.

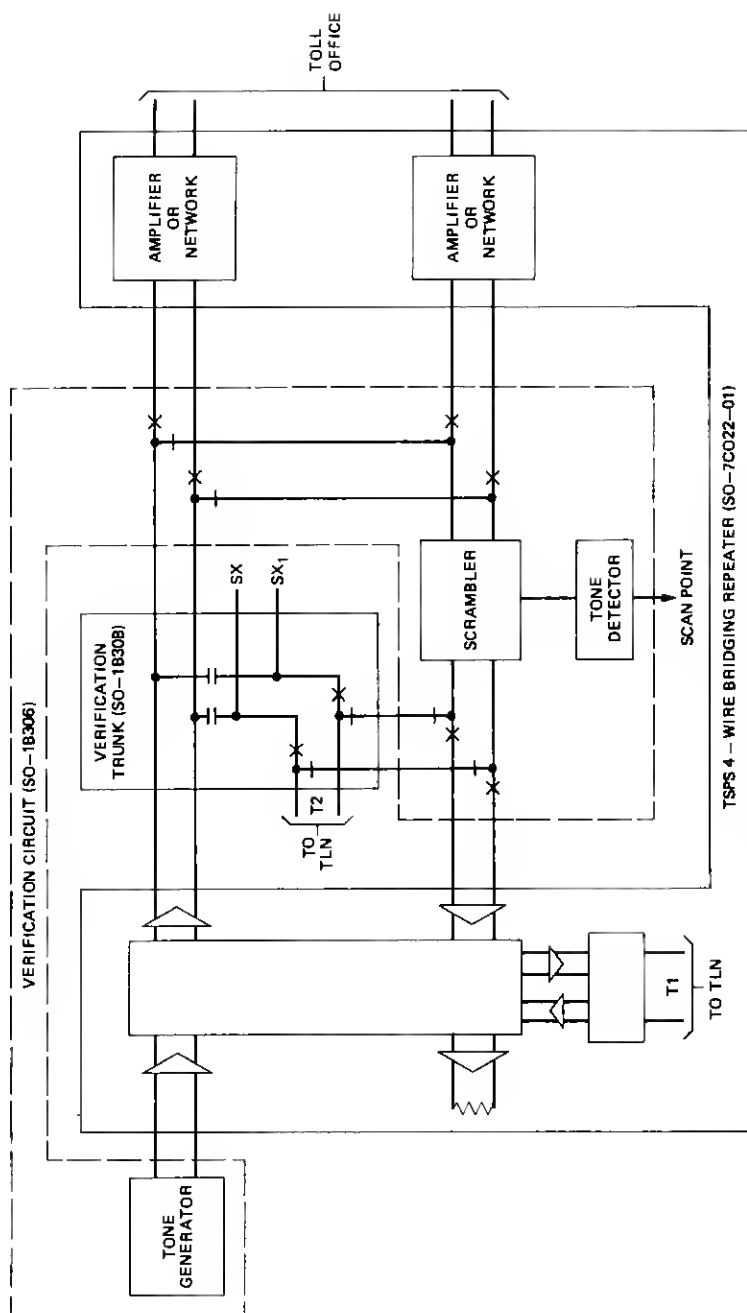
If a circuit passes the operational test, it is used for the verify attempt. If the test fails, the circuit is not used for the verification attempt, and another circuit is automatically selected (and tested). A further consequence of a test failure is that the failing circuit is taken out of service.

5.7 Security TTY message

A message prints out on the security teletypewriter for verification calls that have an emergency interrupt lasting longer than a specified threshold duration.

5.8 Limited network access from the trunk test panel

As discussed further in the next paragraph, craft access of the verification network from the trunk test panel is limited.



VI. BLV MAINTENANCE

Both switch maintenance (circuit functions) and trunk maintenance (transmission tests) of busy line verification trunks and circuits are normally performed from the trunk test panel on the TSPS control, display and test (CDT) frame. The privacy of customers is protected by restricting outpulsing from the CDT on BLV trunks to six digits, thus giving access to toll office test lines but not to station equipment. End-to-end (TSPS to station equipment) service test calls may be made by the craft from a TSPS operator position only (see Section 7.2). The trunks and circuits may be tested singly or in groups with automatic progression or manual steps.

During switch maintenance, the craft may initiate all relay operations and sequence through all verification circuit states. With the assistance of toll office craft, each BLV operational state may be tested. The operational check normally performed during call processing may also be initiated from the CDT. In addition, the beeper and scrambler output levels may be measured. The scrambler output level is checked in both modes (scrambled and unscrambled) using the beeper as a tone source. The difference between the scrambled and unscrambled output levels gives an indication of scrambler performance.

From the CDT, BLV trunk maintenance may be performed semi-automatically using a 104 test line or manually using other 100-type test lines. These test lines are located in the connecting toll office. The tests that may be performed are one- and two-way loss measurements, near-and far-end noise measurements, and frequency response measurements.

VII. ADDITIONAL CAPABILITIES

7.1 Trouble reporting

Operators can enter trouble codes when they encounter problems in handling a call. These entries, known as operator-keyed trouble reports, cause messages to be printed on the maintenance teletypewriter channel and on the trouble report teletypewriter channel. Trouble encountered in the verification network or in collecting charges from a customer is reported using standard procedures and trouble codes. Trouble encountered with the scrambler or tone generator (beeper) is reported with a new trouble code.

7.2 Service test call

The craftsman can place a service test call from an operator position to determine whether lines in an end office can be properly verified and interrupted from the TSPS. This testing is only allowed

when the position has been placed in a special maintenance mode. In this mode, the craftsperson can access a verification trunk by first accessing a delay call trunk, depressing the VFY key, and then accessing an idle loop. This is the only mode in which a busy line verification can be done with a delay call trunk rather than an incoming or inward trunk.

The number to be verified cannot be one of the numbers entered in office data as being excluded from verification. However, no office data check is made to determine whether the TSPS verification service has been activated or whether the local office is within the verification network. (A check is made that the area code can be reached via the verification network.) This implementation allows testing prior to offering busy line verification service and prior to activating verification for a particular local office.

7.3 Maintenance and traffic measurements

Maintenance measurements are printed on the maintenance teletypewriter and on the engineering and service data teletypewriter daily, or hourly on request. They show counts for the preceding 24-hour period. Current values of the counts can also be requested at any time. In addition, once a month the accumulation of the counts for the previous month is printed. The current values of the monthly counts can also be requested at any time. Two maintenance counts were added for busy line verification. One is a count of the number of times a BLV trunk passes the operational test and the other is the number of times a BLV trunk fails that test.

Counts related to BLV traffic volume are printed once a day, and hourly upon request, on the engineering and service data teletypewriter. The traffic counts are:

(i) Total verification attempts. This is a count of the number of times the VFY key was depressed and was lighted either steady or flashing.

(ii) VFY key depressions with all constraints satisfied (so that it lights steady).

(iii) VFY key depressions with the forward number not served by the verification network for this TSPS.

(iv) VFY key depressions with line number not verifiable.

(v) BLV trunk seizures which pass the operational test.

(vi) Emergency interrupt attempts.

In addition to the above traffic counts, other BLV measurements were added to the hourly printout on the engineering and service data teletypewriter. These measurements show the usage of the BLV trunks, the amount of time the BLV trunks were unavailable, and the number of BLV trunk seizures.

7.4 Recent changes

Recent change programs permit the telephone companies to alter office data parameters. Requests for data changes are transmitted over the recent change teletypewriter or a maintenance teletypewriter. The recent change programs check the request for accuracy and alter the office data tables as required.

All BLV trunks at a TSPS are members of a single BLV trunk group. Recent change messages allow the introduction of the BLV trunk group, as well as changes to it. Individual members within the group may be added, deleted, activated, or deactivated.

The area served by the verification network may be identified and modified by the use of recent change messages. This involves specification of the area codes and office codes included in the verification network. Lines, or bands of lines, which are not allowed to be verified can also be identified and modified by recent change.

Recent change messages can be used to specify and change the charges to be collected from or quoted to coin and hotel customers. They may also be used to specify that charges associated with a particular rate schedule must be manually rated.

Office data verification messages are used with recent change messages, or independently, to determine the current values of office data. Such messages are available for the BLV trunk group and its members, for identifying office codes within the BLV network and lines excluded from BLV service, and for determining BLV rates.

7.5 Service evaluation

The Service Evaluation System (SES) is an operations support system that monitors the quality of telephone service received by the customer. Signals sent from TSPS to SES allow evaluation of the service given to a TSPS customer. Calls are evaluated on a sampled basis. When it is determined that a particular call should be evaluated, the service observing monitor circuit is connected concurrently with the operator at the beginning of the call. It is not known at that time whether the customer will request a busy line verification or some other service. If, in fact, BLV service is requested, the status of the VFY and EMER INT lamps are sent to the evaluator. The operator actions involved with placing the customer in hold, accessing an idle loop for verification, reaccessing the customer's loop, etc. are also seen by the evaluator. Charging information, if any, is sent to SES. In addition, the evaluator is connected to the loop currently in access, either the original loop or the verification loop. This allows the evaluator to hear what the operator hears on the verification loop as well as any interruption by the operator. Inward calls are not sent to the Service Evaluation System; therefore, busy line verification service on an inward call is not evaluated.

7.6 Training considerations

TSPS operators are trained at special positions where they can receive and respond to simulated calls.⁵ The modifications noted in Section 4.1, which were made to the regular TSPS operator positions, also had to be made to the training positions.

The simulated calls used in operator training are produced by recording both data patterns and voice passages on master tapes known as training tapes. A support system, called Automated Data Entry Console, is used to edit tapes and synchronize the recording of voice and data. Modifications were made to this system to provide the new tones particular to BLV, including the tone generator used for emergency interrupt. Audio scrambling is also provided by this system so that signals such as voice, busy tones, and reorder tones can be recorded in their normal format. When necessary, the effects of the scrambler are then provided by the Automated Data Entry Console. This system was also modified to provide new codes for the new BLV operator key actions.

VIII. CONCLUSION

The standard busy line verification feature, available with TSPS Generic 1T9, was introduced in Tucson, Arizona, when the 140th Bell System TSPS cut in to service on July 13, 1979. With all TSPS sites planning to advance to Generic 1T9 in the near future, it is anticipated that standard verification arrangements will rapidly be established throughout the Bell System. With these verification networks in place, the efficiencies of TSPS operation can be applied in offering standard BLV service to many of the over 82 million main stations served by the Bell System.

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